Problem 3B.11

**Radial flow between two coaxial cylinders.** Consider an incompressible fluid, at constant temperature, flowing radially between two porous cylindrical shells with inner and outer radii $\kappa R$ and $R$.

(a) Show that the equation of continuity leads to $v_r = C/r$, where $C$ is a constant.

(b) Simplify the components of the equation of motion to obtain the following expressions for the modified-pressure distribution:

$$
\frac{d\mathcal{P}}{dr} = -\rho v_r \frac{dv_r}{dr} \quad \frac{d\mathcal{P}}{d\theta} = 0 \quad \frac{d\mathcal{P}}{dz} = 0
$$

(3B.11-1)

(c) Integrate the expression for $d\mathcal{P}/dr$ above to get

$$
\mathcal{P}(r) - \mathcal{P}(R) = \frac{1}{2} \rho [v_r(R)]^2 \left[ 1 - \left( \frac{R}{r} \right)^2 \right]
$$

(3B.11-2)

(d) Write out all the nonzero components of $\tau$ for this flow.

(e) Repeat the problem for concentric spheres.